An exploration of advancements in energy storage in California since the American Recovery and Reinvestment Act

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1-Dec 2014

Steady technical progress and important customer wins are helping Primus become a leading storage company

Grants

DOE $14M

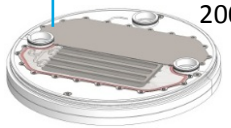
$2M

California Energy Commission $1M

$1M

Primus Power started Aug-09

Titanium electrode and catalytic coating proven Sep-11



200 mA/cm² proven Jun-10

1 kW EnergyCell May-12

2 kW EnergyCell Dec-12

Contact manufacturing agreement Feb-14 SANMINA

Material cost milestone Jul-14

18th patent granted Sep-14

20 kW β EnergyCell Sandia Natl Lab 3rd party test Sep-13

Customers

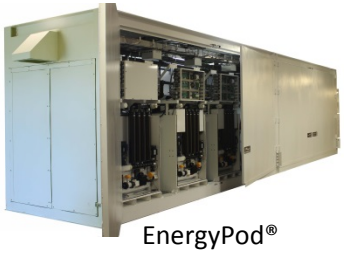
Modesto Muni • Q2-15

Miramar Microgrid • Q2-15

Israel Chemicals • Q1-15 ICL

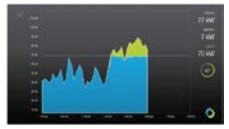
Puget Sound Energy • Q1-15 PSE

Products



EnergyPod®
First ship: Q1-15

EnergyCell
First ship: Q1-15



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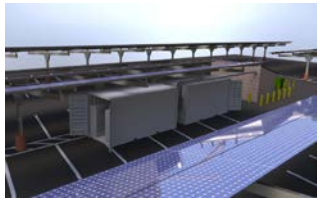
Primus is shipping to utilities, microgrid developers and commercial/ industrial customers

Application	Deployment		Partner
Microgrids & Energy management	**Marine Base at Miramar** Microgrid		Raytheon
Capital Deferral of Distribution Substation	**Puget Sound Energy** Power dense arrays		Power electronics confidential
Local Capacity & Renewable firming	**Modesto Irrigation District** Multi-MW arrays		BOSCH Power electronics confidential
Demand Charge Management	**Israel Chemicals** Single EnergyCell		EMS software provider and integrator confidential

Modesto Irrigation District is a municipal utility in California's central valley

- Independent, publicly owned utility
- 640 MW summer-peaking load
- ~1% of California's energy needs
- Irrigation water to 58,000 acres
- Drinking water to the City of Modesto
- Electricity to 111,000 customers

Source: MID website, MID integrated resource plan 2013

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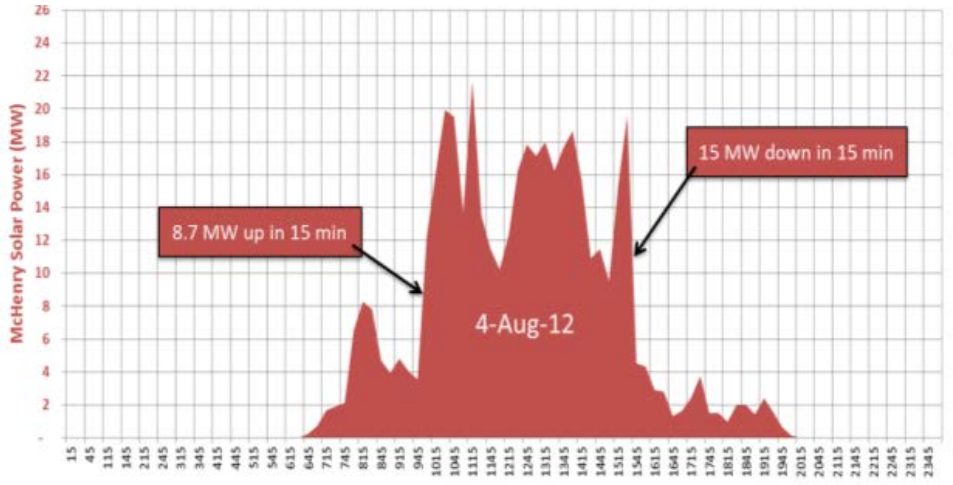
Modesto's generation mix is changing over the next several years

	2014	2020
Renewables	27%	33%
Open market purchases	25%	<39%
Coal	21%	0%
Natural gas	21%	>22%
Hydro	7%	7%
	100%	**100%**

Coal - stable base load – going to zero

Solar – intermittent – increasing



Source: MID website, MID integrated resource plan 2013, Primus estimates

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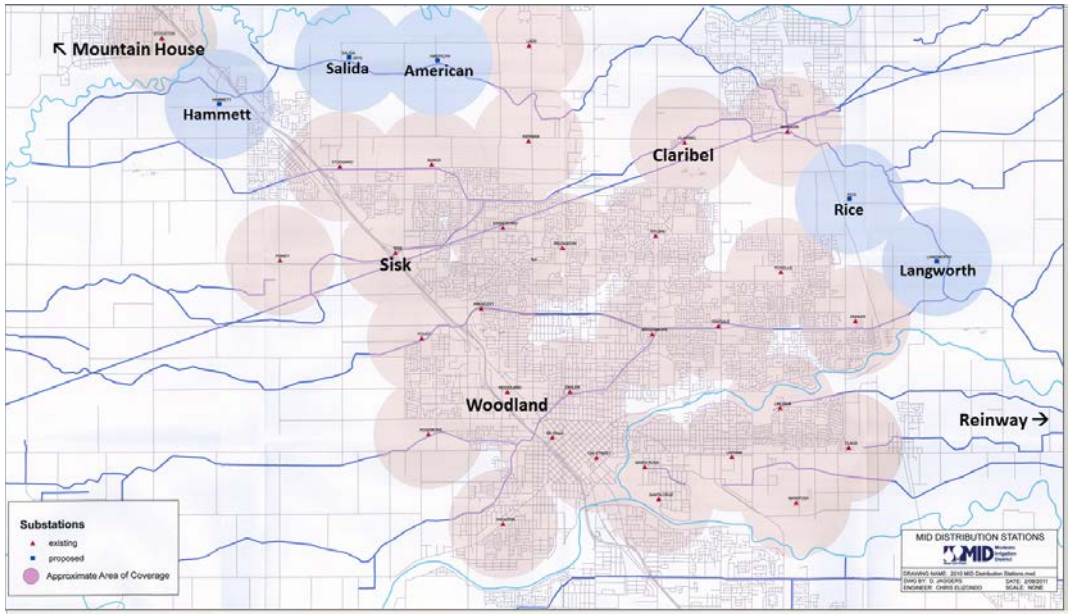
How best to provide grid flexibility: gas or energy storage?

Woodland 3
Centralized gas generators

- 50 MW
- 6 reciprocating engines
- $45M engines
- $33M construction

- 4 year permitting & construction
- 2 acres, new building & road

Energy storage systems
Distributed throughout Modesto's network



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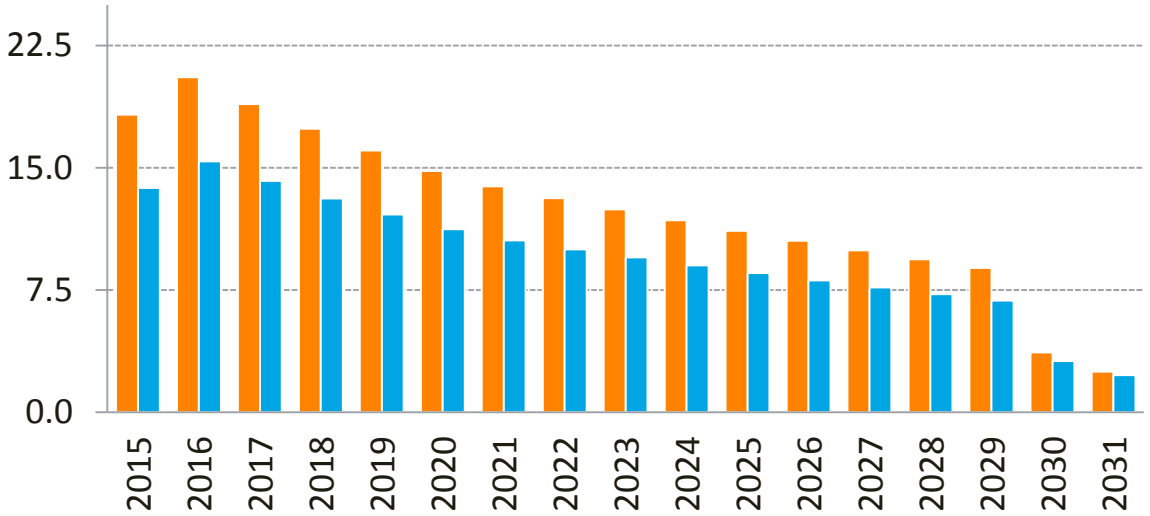
EnergyPods® are less expensive, cleaner, and easier to install alternative to traditional thermal generation

	Natural Gas Reciprocating Engines	Primus Power EnergyPods®
		
Firming range (MW)	4 to 50	-25 to 25
Capital cost	$45M engines + $33M construction	$50M in phases
Permanent fulltime staff	4	0-1
Time to full power (sec)	300	<1
Water use (liters)	66,000	0
Natural gas (MMBtu)	2,900,000	0
Pollutants (metric tons)	20 NOx, 72 CO, 72 VOC	0
CO_2 emissions (metric tons)	66,000	0
Sound (dB)	95 (jackhammer)	30 (whisper)
Permit and install time (months)	36 to 54	2 to 4
Area (acre)	1	¼

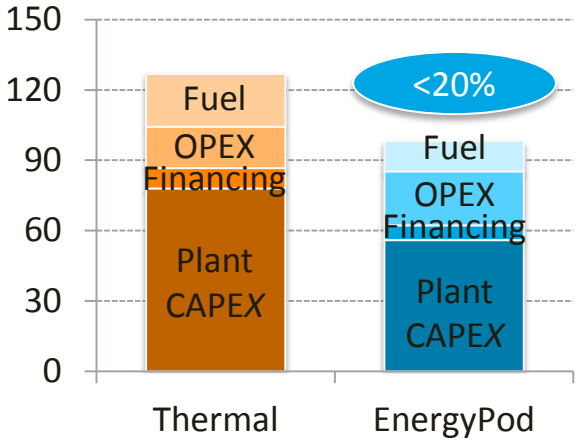
Annual data, based on 35 MW average use. EnergyPods® are charged with renewable solar and wind energy.

EnergyPods® owned by MID will be less expensive to run than a gas peaking asset

Thermal generation vs. EnergyPod® for 50MW of flexible capacity
Discounted costs, $M



Costs by category over asset life
Cumulative discounted costs, $M



- LCOE for EnergyPod® peaking is 20% less than gas peaker ($253 vs. $321/MWh)
- Flexible range of EnergyPods® enables less capacity to be purchased
- Ability to deploy serially in substations to defer upgrades would add value to EnergyPod deployment

Key assumptions:
1 28MW EnergyPods provide the same flexible capacity as 50MW of thermal generation
2 MID purchases 50MW of natural gas reciprocating engines for $78M installed
3 $6/MMBTU natural gas, escalated at 3% p.a., charging energy at $45/MWh escalated at 3% over asset life
4 2015 COD, overnight capital costs realized in year 0
5 Asset owned by MID -- Bond financing:100% financed, 4.7% interest rate, 17year term
6 Battery and Gas turbine LTSAs purchased – Turbine $20/kW, 4.7/kWh and Battery $9.3/kW, $7.7/kWh

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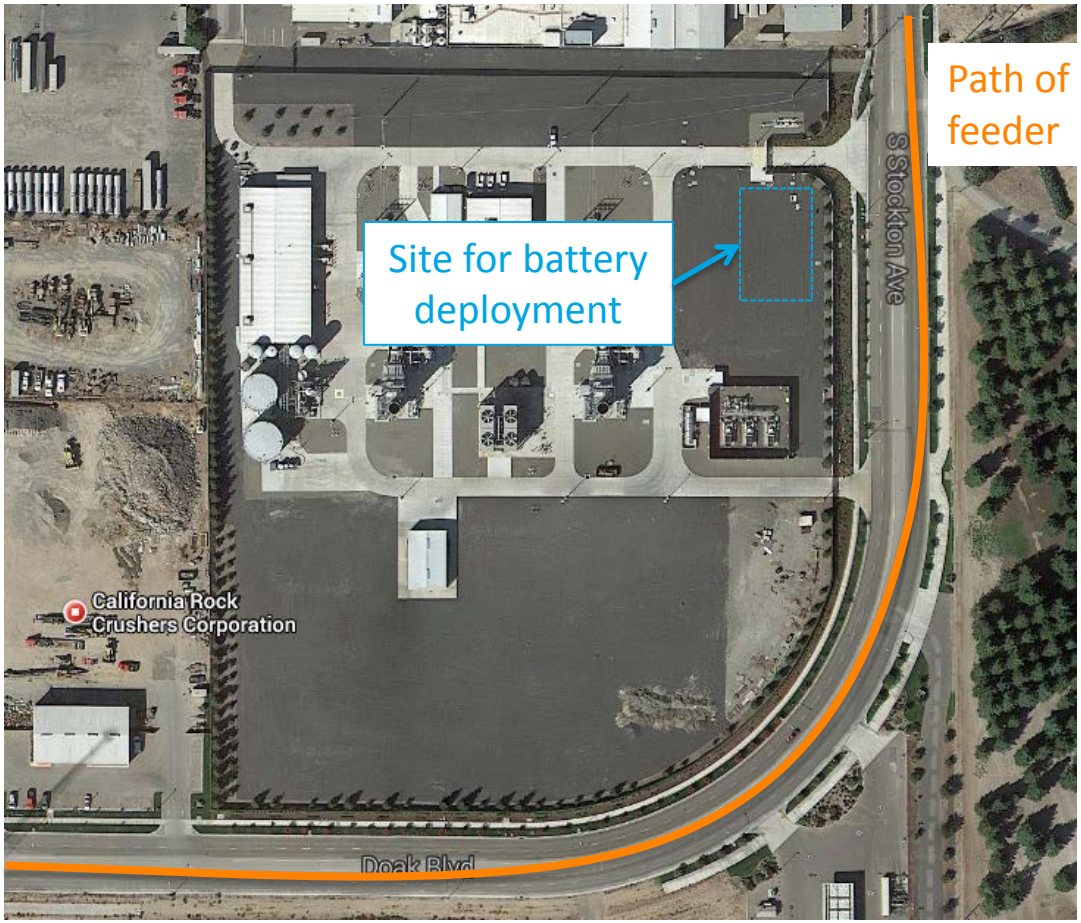
In early 2015 Modesto will deploy the first EnergyPod® at Ripon Generating Station

Ripon Generating Station, aerial view



- Battery deployment expected to interconnect to 17kV underground distribution line
- Site has additional space for expansion after demonstrating of first EnergyPod®
- Battery will be controlled from MIDs load office and will follow a signal that optimizes gas generation to balance renewables

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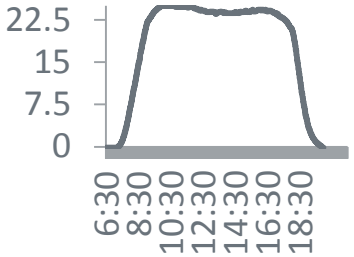
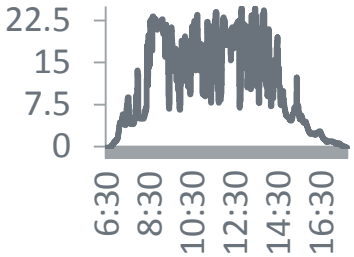
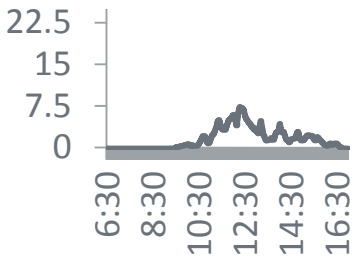
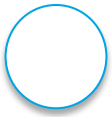
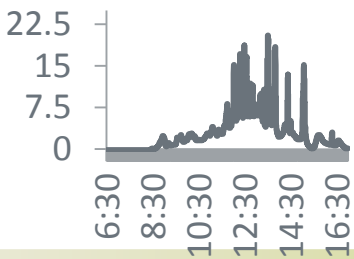
Addressing the high energy, variable days offers the most opportunity

High
Low

Category	Representative Plot	Total # of days (count/%)	Most common month	Relative value of energy storage
Perfect/ near perfect solar day		38%	• September	 Energy shifting to meet peak (e.g., shoulders, mid-day to peak)
High power, energy, variability		37%	• March	 Energy shifting and smoothing to meet peak and avoid rapid cycling of generation assets
Low energy, variability		14%	• December	 Energy shifting to meet peak, make solar "dispatchable"
Low energy, high variability		11%	• December	 Energy shifting to meet peak, and avoid cycling generation

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